NASA TECH BRIEF

Locating 'Sneak Paths" in Electrical Circuitry

EXAMPLE OF A UNIT

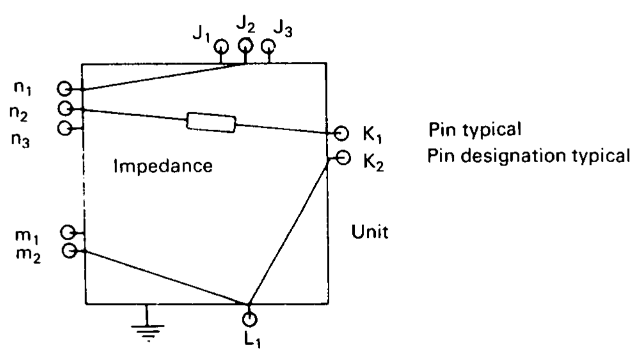

FIGURE A

EXAMPLE OF A MATRIX

	J_1	J_2	J_3	K_1	K_2	L_1	M_1	M_2	N_1	N_2	N_3
J_1	1	0	0	0	0	0	0	0	0	0	0
J_2	0	1	0	0	0	0	0	0	1	0	0
J_3	0	0	1	0	0	0	0	0	0	0	0
K_1	0	0	0	1	0	0	0	0	0	1	0
K_2	0	0	0	0	1	1	0	0	0	0	0
L_1	0	0	0	0	1	1	0	1	0	0	0
M_1	0	0	0	0	0	0	1	0	0	0	0
M_2	0	0	0	0	0	1	0	1	0	0	0
N_1	0	1	0	0	0	0	0	0	1	0	0
N_2	0	0	0	1	0	0	0	0	0	1	0
N_3	0	0	0	0	0	0	0	0	0	0	1

FIGURE B

A troublesome phenomenon in the operation of electrical circuitry is the existence of "sneak paths" that degrade performance and can, in "worst case" situations destroy circuitry. "Sneak paths" are defined as unplanned closed current paths which can be completely described by circuit diagrams within defined limits. These paths normally contain two undesirable characteristics: 1, the existence of unwanted electrical currents in these paths, and 2, the almost impossible task of locating these paths.

To attack the problem, all possible closed loops must be located. An exception to this is the technique for removing a majority of the normally designed power loops. Because it is predicted that the total number of these loops is low, the task of segregating the "sneak paths" from the normally designed power loops by direct examination of circuit diagrams is possible. Another simplification is to separate the task into two levels. The first level is the cable diagram, where each cable is considered as a single path; and the second level is the individual wire path. The first level is reduced to its lowest number of possible cable loops, while each closed wire path within these cables is recorded. Finally the "sneak paths" are separated from the designed closed loops.

One effective approach to accomplishment of the above outlined problem is the use of a matrix system wherein circuit pin connections are assigned arbitrary

(continued overleaf)

designators and these used in formation of the matrix. Such a tool is illustrated in the figures A and B. A matrix is a format that shows the current paths passing through a "unit". This current path is defined as follows: (1) The conducting current is one mil-amp or more; (2) The impedance is 28K or less (from one end of a path to the other); (3) The frequency range is from D.C. to 1000 Hz. (4) This path is an actual part of the circuit design. It has no inductive or capacitive coupling characteristics as are often found in long cables containing many conductors.

The "unit" is the black box that normally describes electrical circuits. All the terminals in this unit are the pins of the cable attached to this unit. One possible exception to this would be the chassis ground connections.

The format (or matrix) is a rectangular representation of the possible current paths passing through a unit (Figure B). Example, to show the electrical path from pin N_2 to K_1, place the numerical "1" in the K_1 column and N_2 row. This "1" entry indicates a conducting path from N_2 to K_1 or from K_1 to N_2, according to the above definition of current paths. In noting the direction of current flow, N_2K_1 represents positive current flow (opposite electron flow) from N_2 to K_1. Various types of impedances can be listed in the matrix by replacing the 1 with the appropriate code number or letter.

The above discussion pertains to the normal matrix (or single wire paths). However, a special type of matrix is called the connector matrix. This matrix represents a cable with several conductors in one current path. If one or more current paths exist between any two cables (J and K respectively), "1" is placed in the J(th) row and K(th) column and a "1" is also placed in the K(th) row and J(th) column. In the event that a current path between cable J and cable K is nonexistent, a "0" is placed in the matrix instead of the "1". Although the present definition considers only designed current paths, this definition can be extended to include paths of all types. This is accomplished by adding code letters to represent these new energy paths, in addition to the present code letters representing impedance.

Note:

Documentation for the invention is available from:
Clearinghouse for Federal Scientific
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